Building Envelope

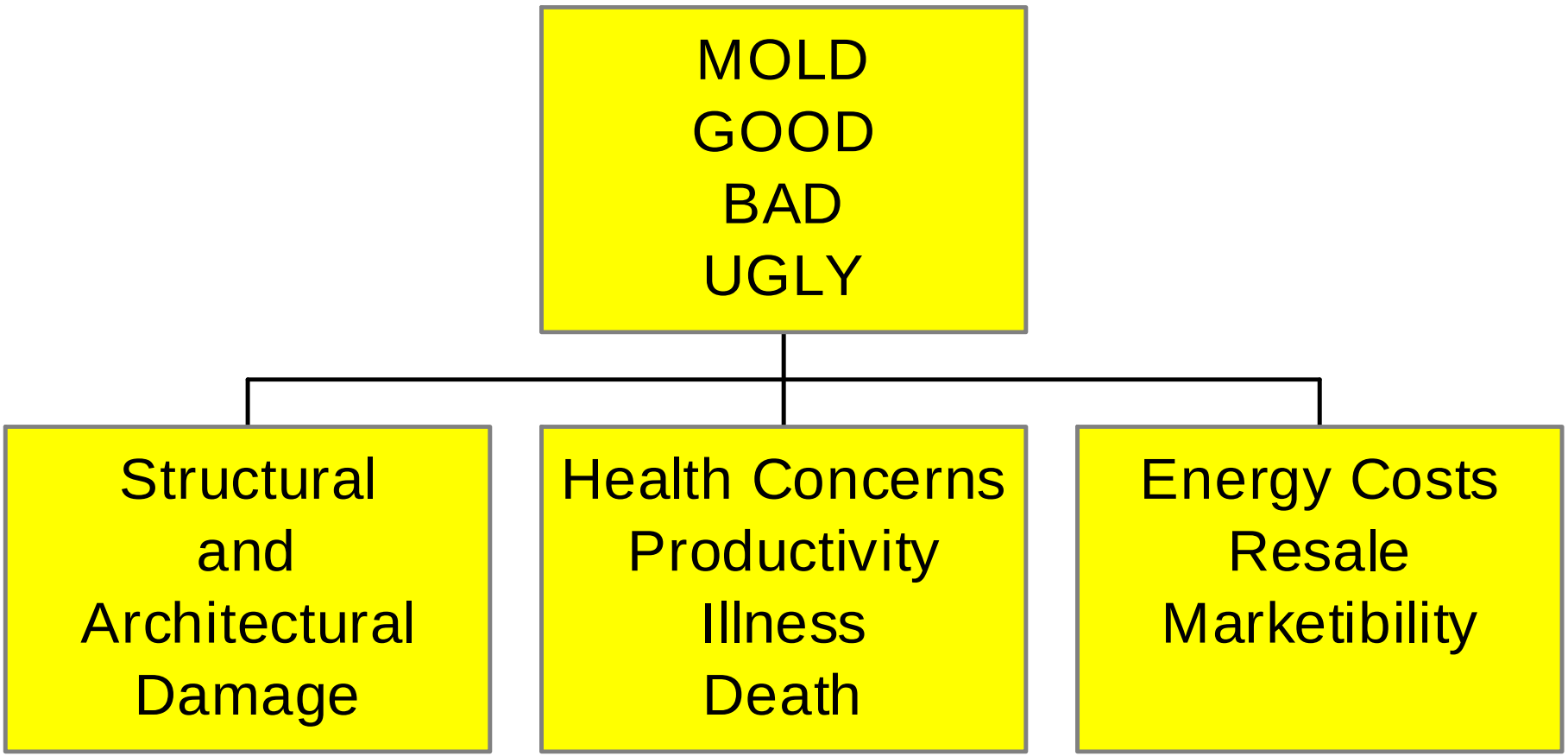
Nolan Day
WR Meadows

Per the E.P.A

•70-90% of our lives are spent indoors

The American Association of Home Inspectors found mold in 38% of the homes they inspected

Moisture


MOLD
GOOD
BAD
UGLY
Structural and Architectural Damage
Health Concerns Productivity Illness Death
Energy Costs Resale Marketibility

Overview

What is an Air Barrier System?

An Air Barrier System is a system of building components within the building envelope designed and installed in such a manner as to stop the flow of air into and through the building envelope system.

Why use Air Barrier Systems?

The U. S. Government now requires them on federal building projects.

The U.S. Department of Energy has determined that 40% of a buildings energy consumption to heat and / or cool the building is due to air leakage.

The use of Air Barrier systems result in:

- Reduced building energy consumption
- Reduced building heating and cooling costs
- Reduced fossil fuel consumption
- Reduced pollution emissions
- Reduction of the Greenhouse Effect
- Improved indoor air quality
- Reduced building envelope system problems

The U.S. Department of Energy has instituted a program of goals to reduce building energy consumption by 25% by the year 2010 and by 50% by the year 2020.

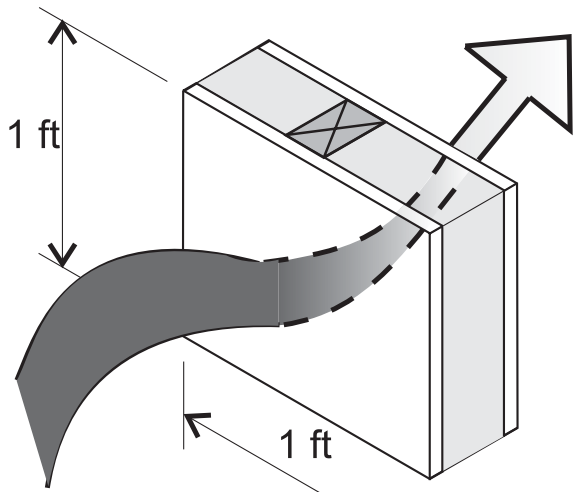
Cross-cutting Issues Related to Building Envelope

Goals/Cross-Cutting Issues

	Health and IAQ	Thermal Comfort	Visual Comfort	Acoustic Comfort	Security and Safety	Ecosystem Protection	Energy Efficiency	Water Efficiency	Materials Efficiency	Building as a Teaching Tool
Site Design	●	●	●	●	●	●	●	●	●	●
Daylighting and Windows		●	●		●		●		●	●
Energy-Efficient Building Shell		●		●			●		●	●
Lighting and Electrical Systems		●	●				●			●
Mechanical and Ventilation Systems	●	●		●	●		●	●	●	●
Renewable Energy Systems		●					●			●
Water Conservation								●		●
Recycling Systems and Waste Management						●			●	●
Transportation					●	●	●			
Resource-Efficient Building Products	●			●		●	●		●	●

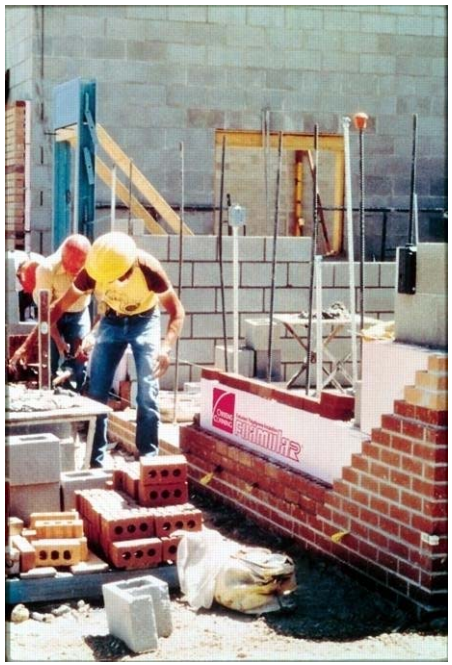
Heat Transfer through Building Envelope

- U-factor
- R-values
- Thermal Mass
- Heat Capacity



U-Factor is the rate of heat flow in Btu/h through one ft^2 area when one side is 1° F warmer

Heat Transfer through Building Envelope



Heat Transfer through Building Envelope

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Flashing Details Are Very Important

Heat Transfer through Building Envelope

- U-factor
- R-values
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Heat Transfer through Building Envelope

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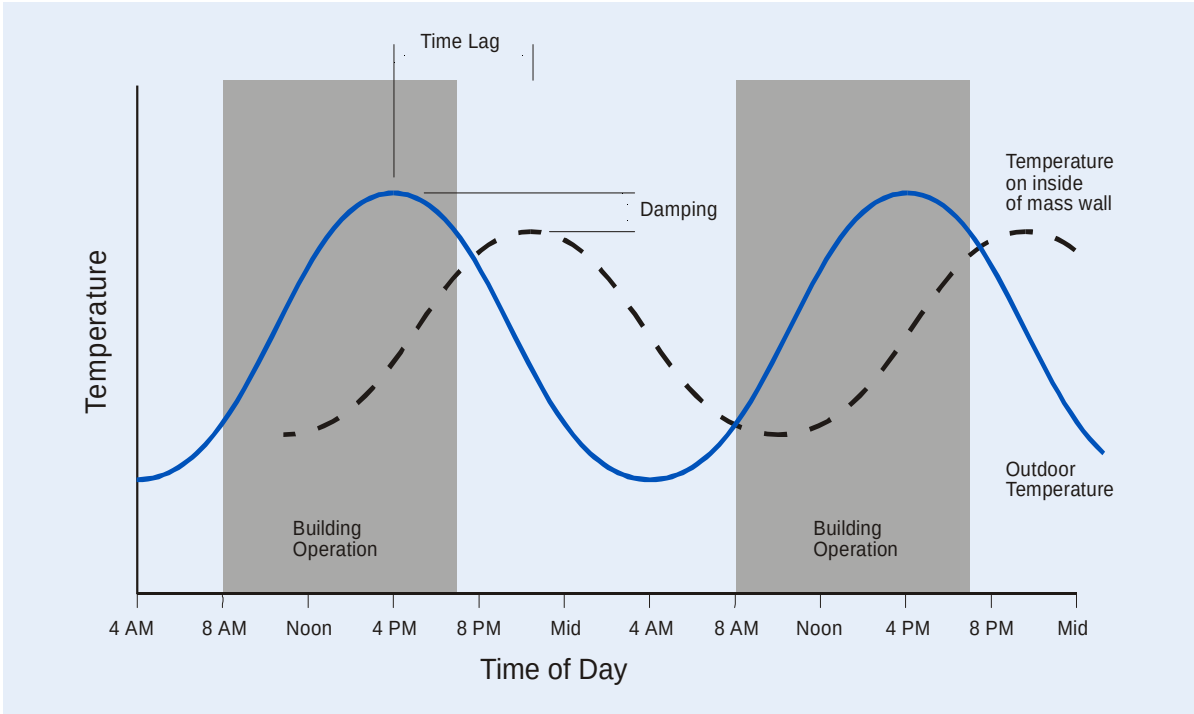

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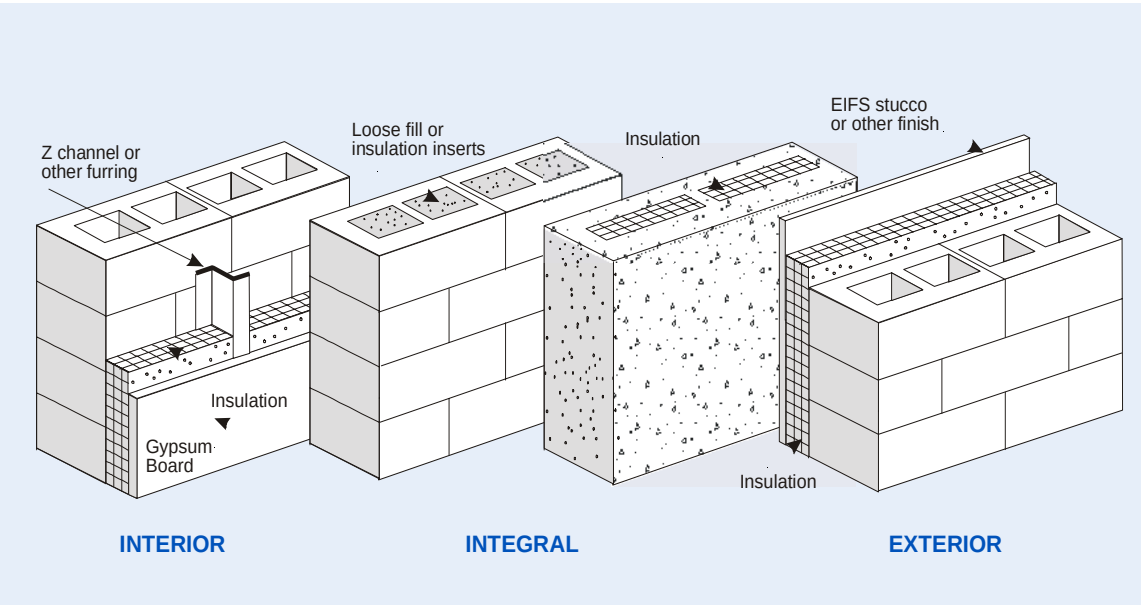


Minimum R-values from ASHRAE 90.1

	Climate Region						
	Hot and Dry	Hot and Humid	Temperate and Humid	Temperate Mixed	Cool and Humid	Cool and Dry	Cold and Humid
	(Phoenix)	(Orlando)	(Atlanta)	(Seattle)	(Boston)	(Denver)	(Minneapolis)
Roofs							
Insulation Entirely above Deck	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-15 ci
Attic and Other	R-30	R-30	R-30	R-30	R-30	R-30	R-38
Walls, Above Grade							
Mass	NR	NR	R-5.7 ci	R-5.7 ci	R-7.6 ci	R-7.6 ci	R-9.5 ci
Steel Framed	R-13	R-13	R-13	R-13	R-13+3.8 ci	R-13+3.8 ci	R-13+3.8 ci
Wood Framed and Other	R-13	R-13	R-13	R-13	R-13	R-13	R-13
Wall, Below Grade							
Below Grade Wall	NR	NR	NR	NR	NR	NR	NR
Floors							
Mass	R-4.2 ci	R-4.2 ci	R-6.3 ci	R-6.3 ci	R-8.3 ci	R-8.3 ci	R-8.3 ci
Steel Joist	R-19	R-19	R-19	R-19	R-19	R-19	R-30
Wood Framed and Other	R-19	R-19	R-19	R-19	R-30	R-30	R-30
Slab-On-Grade Floors							
Unheated	NR	NR	NR	NR	NR	NR	NR
Heated	R-7.5@12 in.	R-7.5@12 in.	R-7.5@12 in.	R-7.5@24 in.	R-10@36 in.	R-10@36 in.	R-10@36 in.

Note: “ci” means continuous insulation. “NR” means no requirement.

Recommended R-values for schools

	Climate Region						
	Hot and Dry	Hot and Humid	Temperate and Humid	Temperate Mixed	Cool and Humid	Cool and Dry	Cold and Humid
	(Phoenix)	(Orlando)	(Atlanta)	(Seattle)	(Boston)	(Denver)	(Minneapolis)
Roofs							
Insulation Entirely above Deck	R-20 ci	R-20 ci	R-20 ci	R-20 ci	R-20 ci	R-20 ci	R-20 ci
Attic and Other	R-38	R-38	R-38	R-38	R-38	R-38	R-60
Walls, Above Grade							
Mass	R-7.6 ci	R-7.6 ci	R-9.5 ci	R-11.4 ci	R-13.3 ci	R-13.3 ci	R-15.2 ci
Steel Framed	R-13+3.8 ci	R-13+3.8 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci
Wood Framed and Other	R-13	R-13	R-13	R-13	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci
Wall, Below Grade							
Below Grade Wall	NR	NR	NR	R-7.5 ci	R-7.5 ci	R-7.5 ci	R-7.5 ci
Floors							
Mass	R-8.3 ci	R-8.3 ci	R-8.3 ci	R-10.4 ci	R-12.5 ci	R-12.5 ci	R-14.6 ci
Steel Joist	R-30	R-30	R-30	R-30	R-30	R-30	R-38
Wood Framed and Other	R-30	R-30	R-30	R-30	R-30	R-30	R-30
Slab-On-Grade Floors							
Unheated	NR	NR	NR	NR	R-10@24 in.	R-10@24 in.	R-15@24 in.
Heated	R-7.5@12 in.	R-7.5@12 in.	R-10@36 in.	R-10@36 in.	R-10	R-10	R-15

Note: “ci” means continuous insulation. “NR” means no requirement.

Measuring Thermal Performance

- Calculation Methods
  - Series
  - Parallel Path
  - Effective R-value
  - Two-dimensional
  - Testing
- Computer Programs
- Pre-calculated Data

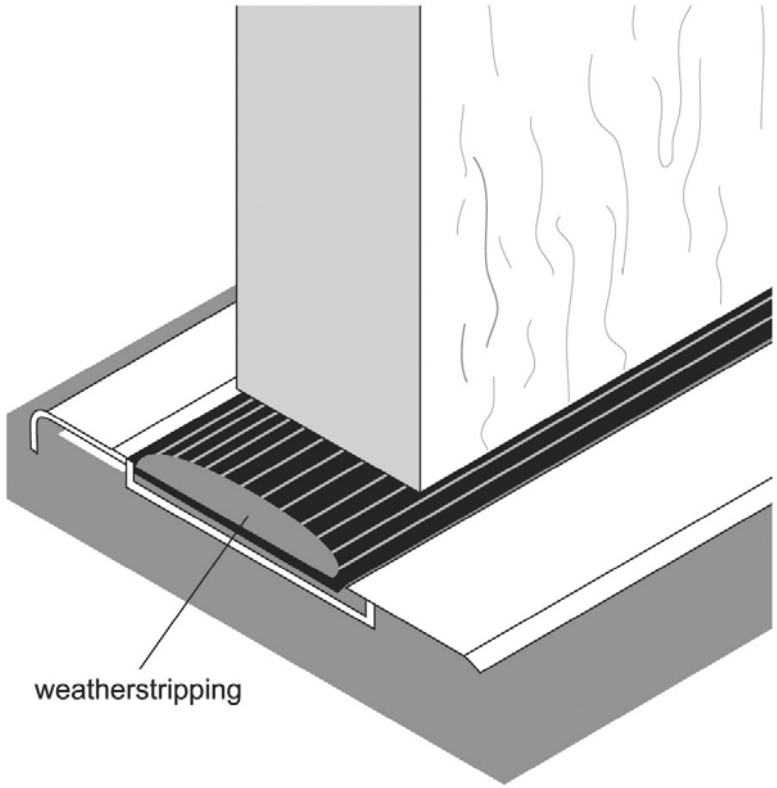
Moisture Control

- Vapor migration occurs from the warm humid side to the cool dry side of the construction where it can condense and lead to mold growth.
- Install vapor barriers on the warm, moist side of framed walls, doors and roofs:
  - Outside of the assembly in humid climates.
  - Inside the assembly for non-humid climates.
- Provide adequate ventilation in attics, crawl space, wall cavities (only in extreme climates).

Air Infiltration

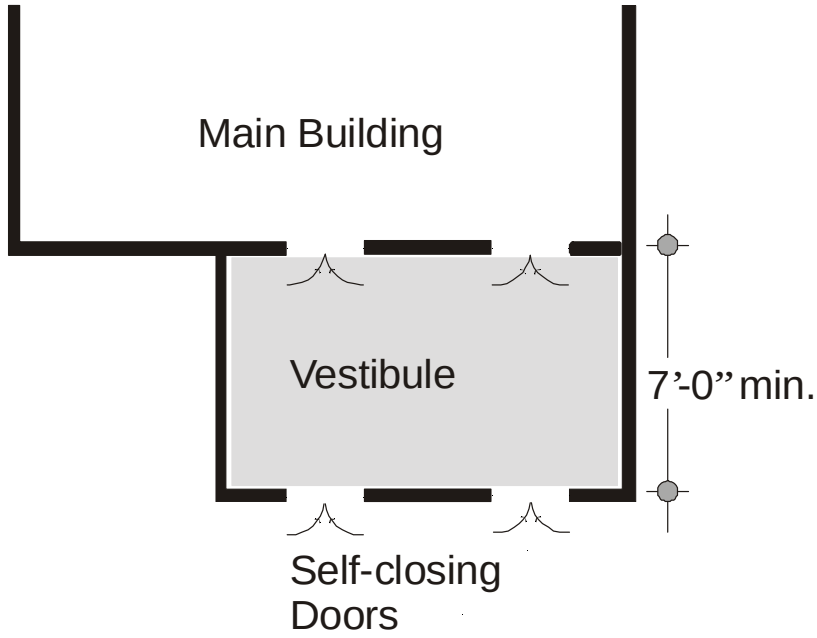
Strategies for reducing infiltration:

- Continuous air barrier on roof and walls.
- Windows/doors with low rates of infiltration.
- Weatherstripping.
- Using air lock entries in cold climates.



Air Infiltration

- Vestibule doors should be at least 7 feet from the school's main entrance.
- Vestibule doors should have self-closing devices.



Insulation Recommendations – Wood Framed Walls

- Install a minimum of R-13 cavity insulation in all climates.
- In the Cool and Humid, Cold and Humid, and Cool and Dry climates, also install R-7.5 insulating sheathing.

Insulation Recommendations – Metal-Framed Walls

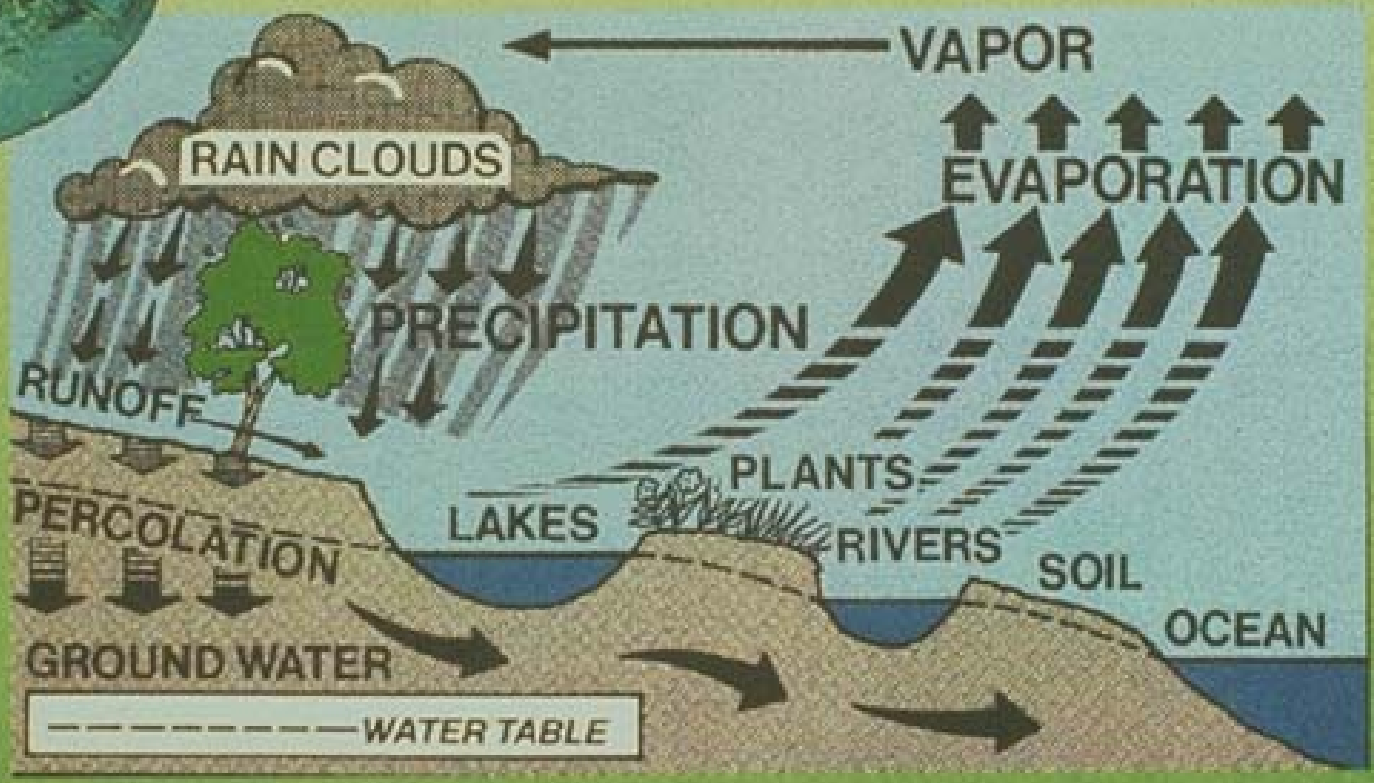
- Install a minimum of R-13 cavity insulation in all climates.
- In the Hot and Humid and Hot and Dry climates, also install R-3.8 continuous insulating sheathing. In the other climates, use R-7.5 continuous insulating sheathing.

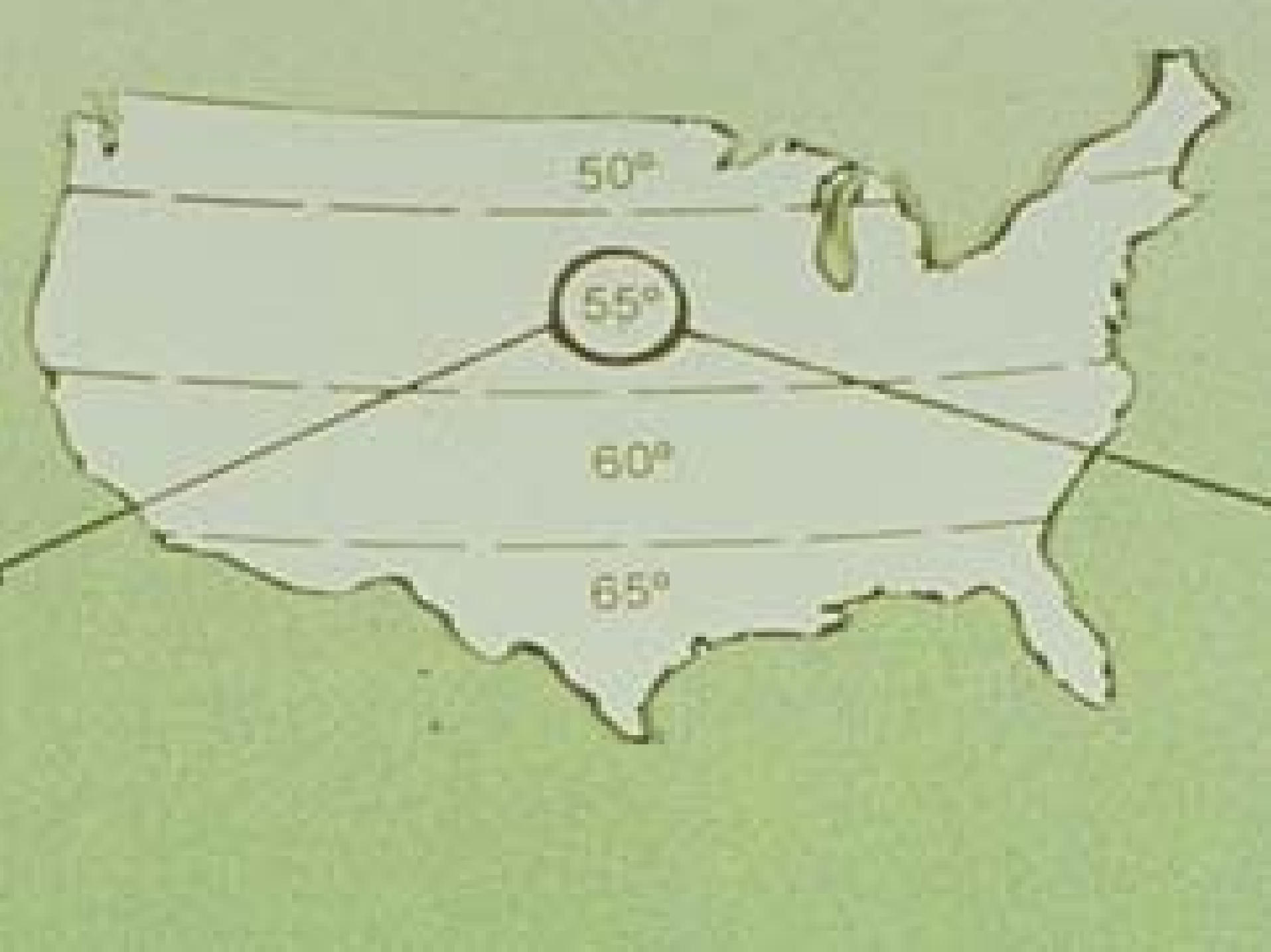
Insulation Recommendations – Mass Walls

- Install R-7.6 continuous insulation in the Hot and Dry and Hot and Humid climates.
- Upgrade this to R-9.5 in the Temperate and Humid climate, to R-13.3 in the Cool and Humid and Cool and Dry climates, and to R-15.2 in the Cold and Humid climate.
- Higher levels of insulation may be appropriate depending on local climate.

Insulation Recommendations – Mass Walls

THE HYDROLOGIC CYCLE AND MOISTURE MIGRATION



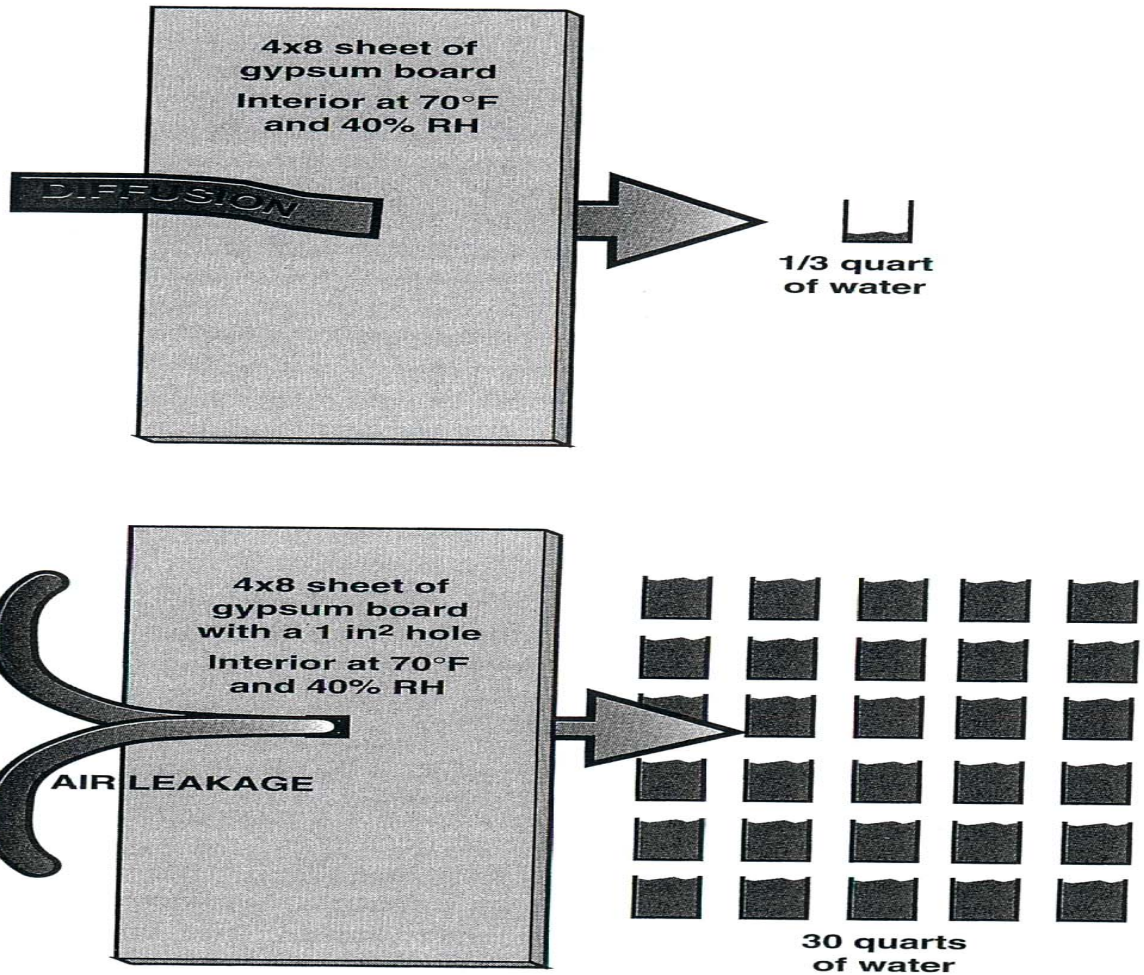

50°
55°
60°
65°

U.S. Department of Energy

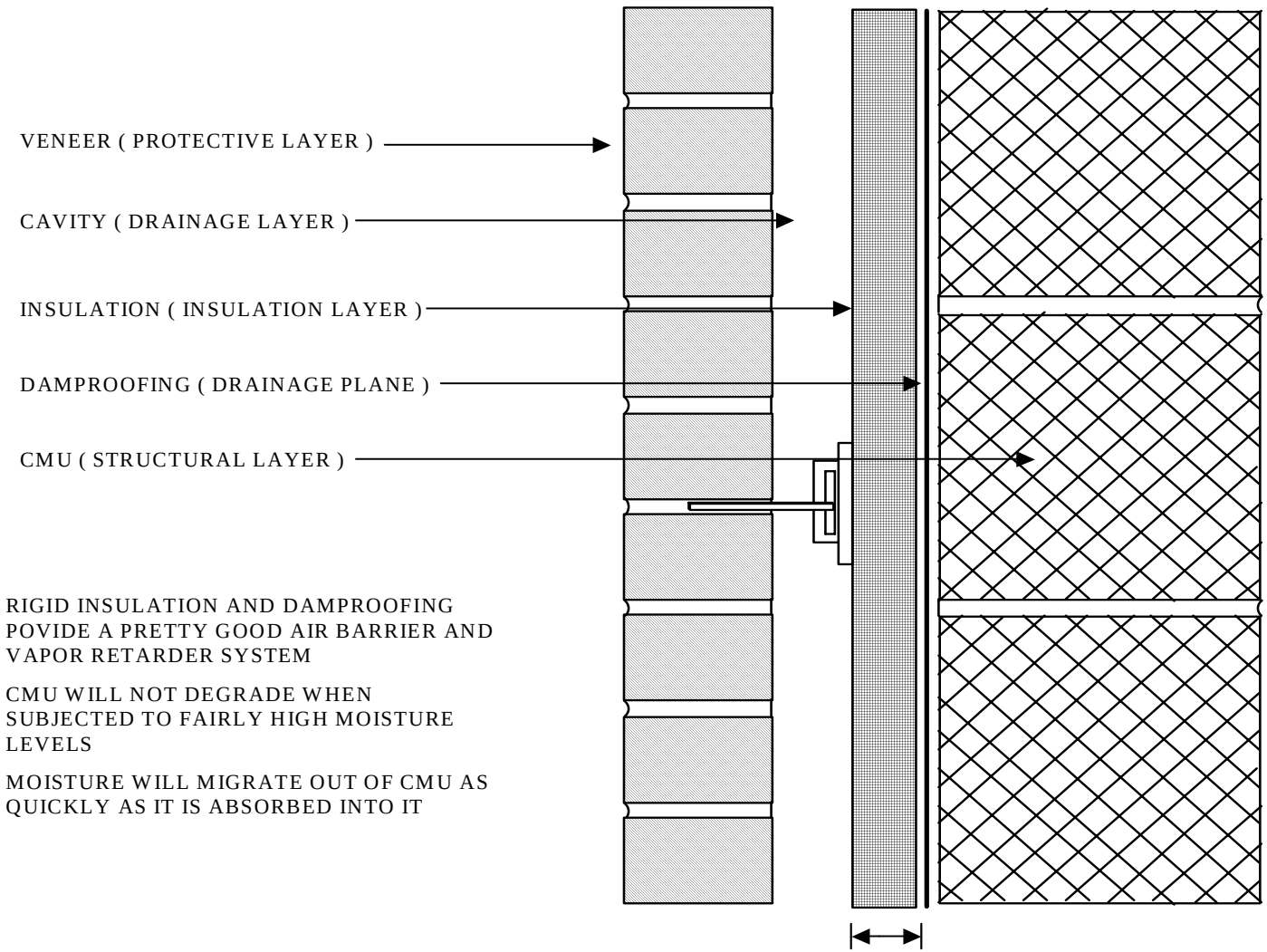
LAWS OF PHYSICS

VAPOR PRESSURE,
as a Function of Temperature & Relative Humidity

TEMPERATURE	RELATIVE HUMIDITY									
	100	90	80	70	60	50	40	30	20	10
100	.948	.854	.758	.663	.569	.474	.379	.284	.189	.095
90	.639	.621	.551	.482	.414	.344	.275	.209	.138	.069
80	.506	.455	.405	.357	.303	.253	.202	.152	.101	.051
75	.429	.386	.343	.300	.258	.214	.172	.129	.086	.043
70	.362	.326	.290	.253	.217	.181	.145	.108	.072	.036
65	.305	.274	.244	.213	.183	.152	.122	.091	.061	.030
60	.256	.230	.205	.179	.153	.128	.102	.077	.051	.026
55	.214	.192	.171	.149	.128	.107	.085	.064	.042	.021
50	.178	.160	.142	.124	.107	.089	.071	.053	.036	.018


4x8 sheet of gypsum board
Interior at 70°F and 40% RH
DIFFUSION
1/3 quart of water
4x8 sheet of gypsum board with a 1 in² hole
Interior at 70°F and 40% RH
AIR LEAKAGE
30 quarts of water

BUILDING EXTERIOR WALLS 30 YEARS AGO

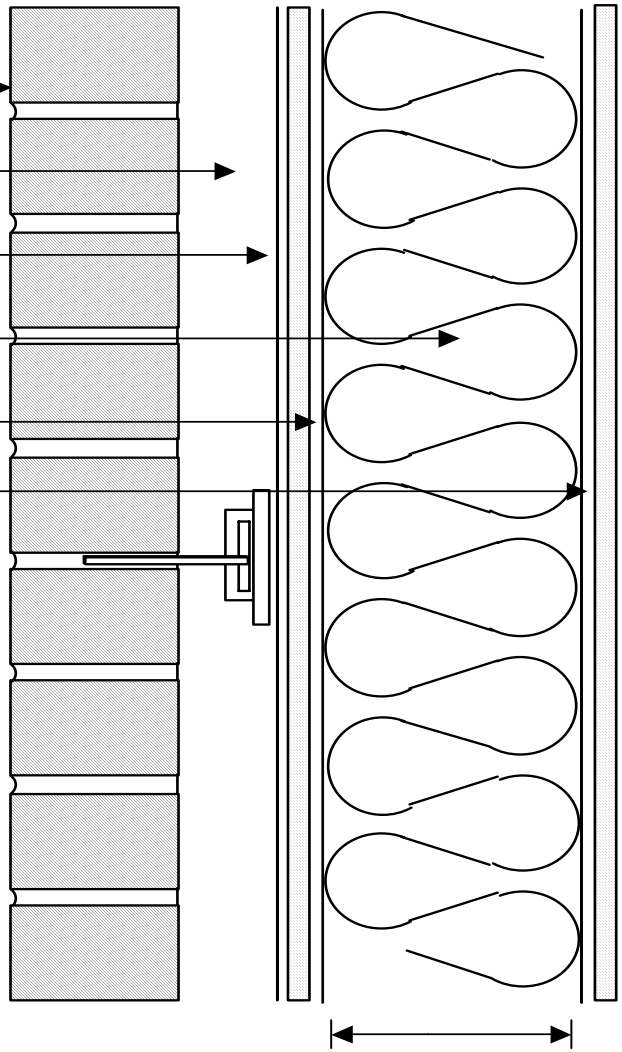


RIGID INSULATION AND DAMPROOFING POVIDE A PRETTY GOOD AIR BARRIER AND VAPOR RETARDER SYSTEM

CMU WILL NOT DEGRADE WHEN SUBJECTED TO FAIRLY HIGH MOISTURE LEVELS

MOISTURE WILL MIGRATE OUT OF CMU AS QUICKLY AS IT IS ABSORBED INTO IT

Building Envelope Systems Today



VENEER (PROTECTIVE LAYER)

CAVITY (DRAINAGE LAYER)

MOISTURE BARRIER (DRAINAGE PLANE)

INSULATION (INSULATION LAYER)

LGMF & GWB (STRUCTURAL LAYER)

VAPOR BARRIER (VAPOR LAYER)

BRICK VENEER IS A " RESEVOIR " CLADDING MATERIAL. IT WILL HOLD MOISTURE AND WHEN HEATED BY SOLAR RADIATION, WILL CREATE EXTREME TEMPERATURES AND VAPOR PRESSURE LEVELS IN THE CAVITY SPACE

GWB IS NOT PROTECTED FROM MOISTURE INTRUSION IN ITS GASEOUS FORM

GWB ABSORBS AND RETAINS MOISTURE AND WILL DEGRADE OR DETERIORATE UNDER FAIRLY LOW MOISTURE CONTNENT LEVELS AS WELL AS HOST MICROBIAL GROWTH

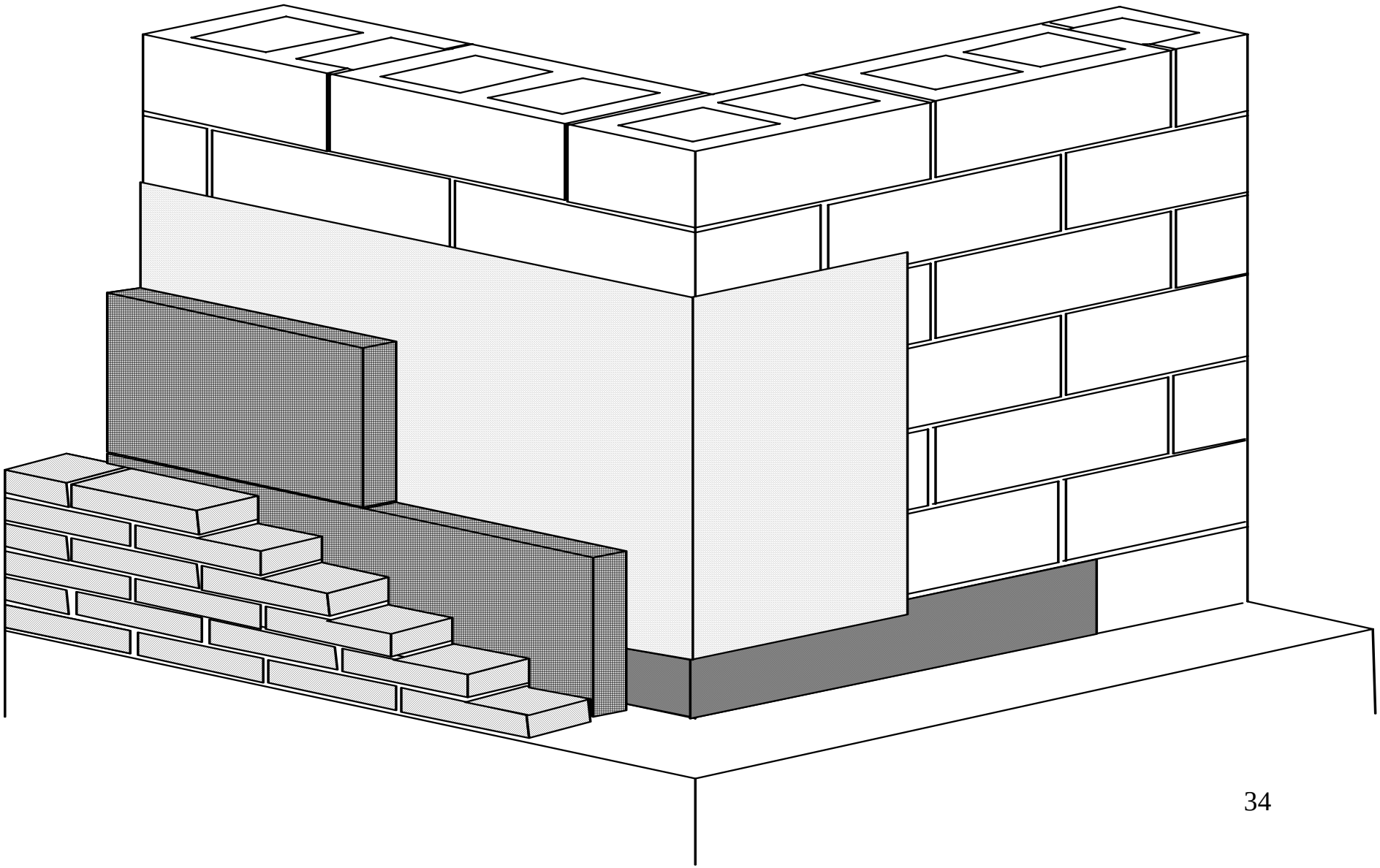
LGMF SYSTEMS WITH GWB AND VAPOR BARRIERS CREATE CHAMBERS FROM WHICH VAPOR CANNOT BE EASILY VENTED

LGMF MEMBERS WILL CORRODE WHEN EXPOSED HIGH RH LEVELS

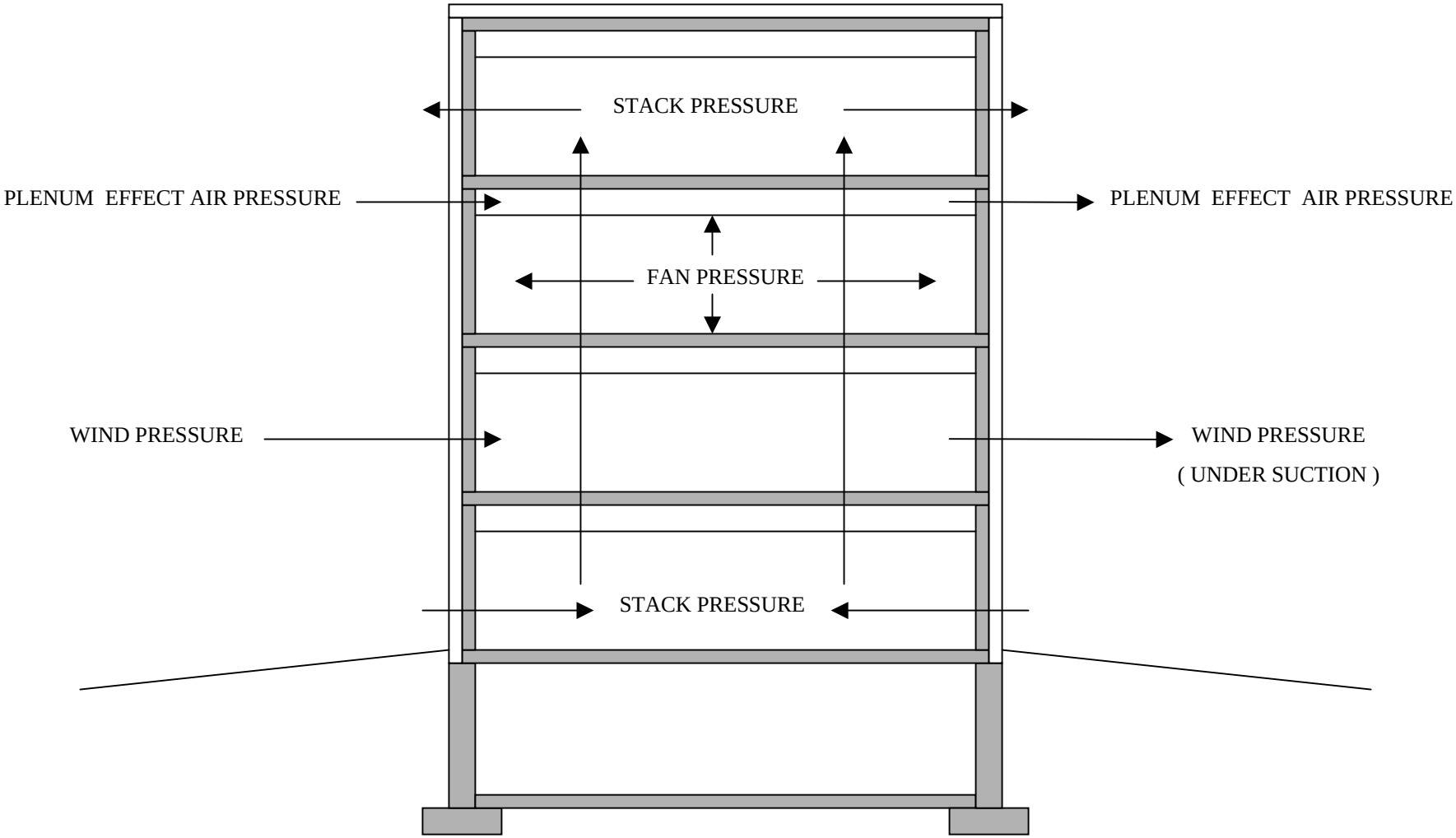
DEW POINT RANGE

INTERIOR

HEATED, COOLED AND *HUMIDITY CONTROLLED* ENVIRONMENT



Pressures


STACK PRESSURE
PLENUM EFFECT AIR PRESSURE
PLENUM EFFECT AIR PRESSURE
FAN PRESSURE
WIND PRESSURE
WIND PRESSURE
(UNDER SUCTION)
STACK PRESSURE

Epoxy Injection Ports should be spaced appropriately.

Example of what can happen when air flow relocates a building envelope system's dew point into the veneer layer.

Air And Vapor Barriers

Metal

Glass

Modified bituminous self adhering membrane

Modified bituminous torch grade membrane

Foil back urethane insulation: 1” or thicker

Foil back gypsum board: 1/2” or thicker

Certain asphalt impregnated fiber board

Certain fluid applied membranes

Sealants (Caulking)

Plastic

Certain trowel applied modified asphalt emulsions

Certain urethane insulation materials

Certain foam insulation

Air Barriers

Plywood sheathing: 3/8” or thicker

Smooth surface roofing membrane

Cement board: 1/2” or thicker

Extruded Polystyrene: 1 1/2” or thicker

Gypsum board (Use moisture resistant board)

Concrete

Phenolic insulation board: 15/16” or thicker

Materials that do not meet the requirements to be an Air Barrier

Plywood sheathing: Less than 3/8” thick

Reinforced non perforated polyolefin

Tempered hardboard

Asphalt saturated felt paper: 15# and 30#

Plain fiberboard

Spunbonded olefin film

Vermiculite insulation

Concrete masonry units

Flakewood board

Particle board

Expanded polystyrene

Glass fiber rigid insulation board

Asphalt impregnated fiberboard

Glasswool insulation

Cellulose insulation

Brick

Wall order of assembly

- Air barriers must be installed on the warm side of the insulation. This way, any moisture that forms will occur on the outside of the air barrier. The moisture will be reabsorbed into the exterior atmosphere or drained away through flashings and /or floor slabs.

- Thermal insulation must be in direct contact with air barrier membrane, installed tight. Direct contact between insulation and the air barrier prevents the generations of convective air currents that can lead to water vapor and condensation problems.

Wall order of assembly

- In hot and humid, air flow retarders should be installed on the exterior of the building, and building assemblies should protect the outside wall surface from getting wet. Any moisture should be allowed to drain away or dry toward the interior, using permeable interior wall finishes and avoiding wall coverings.

Problems Related To Slab Moisture

DUSTING - water trowled into surface

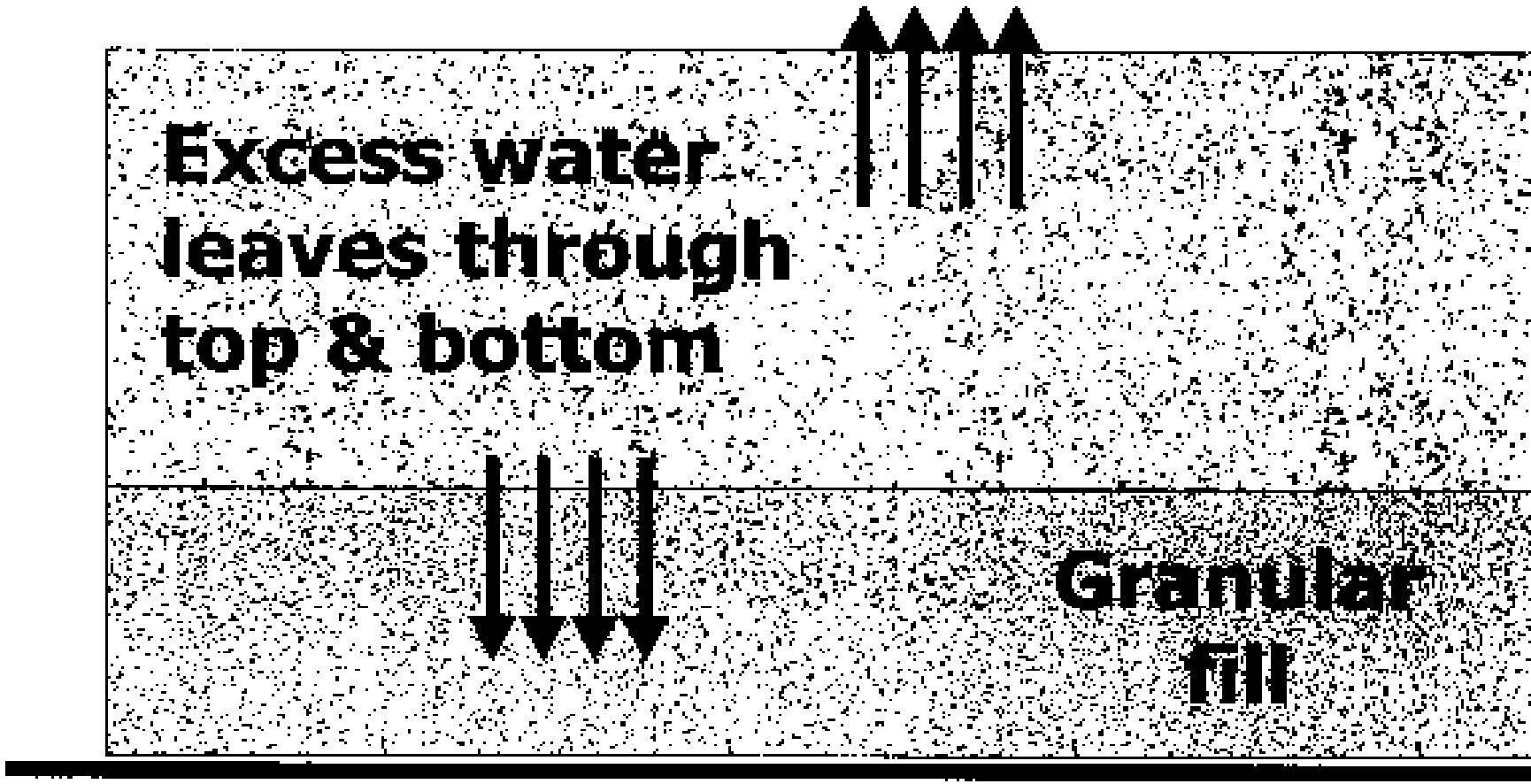
SCALING - high permeability in surface

BLISTERING - premature finishing discolor

CURLING - differential drying/curing

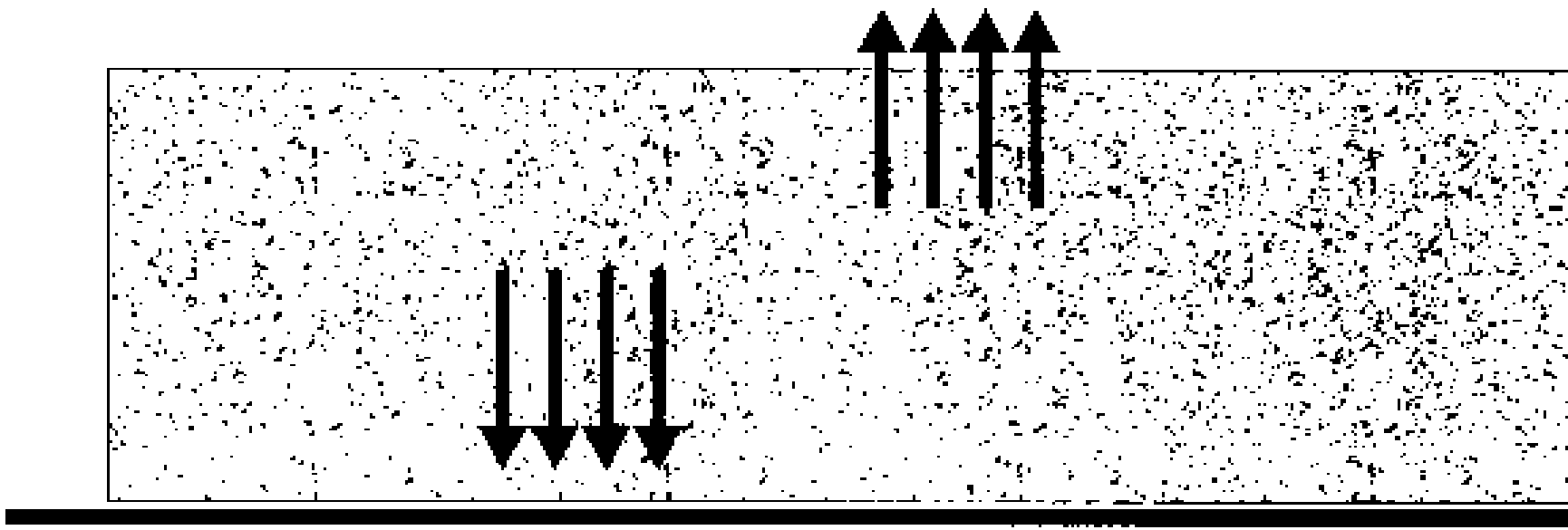
CRACKING - excess water & evaporation

Subgrade preparation



Subgrade preparation

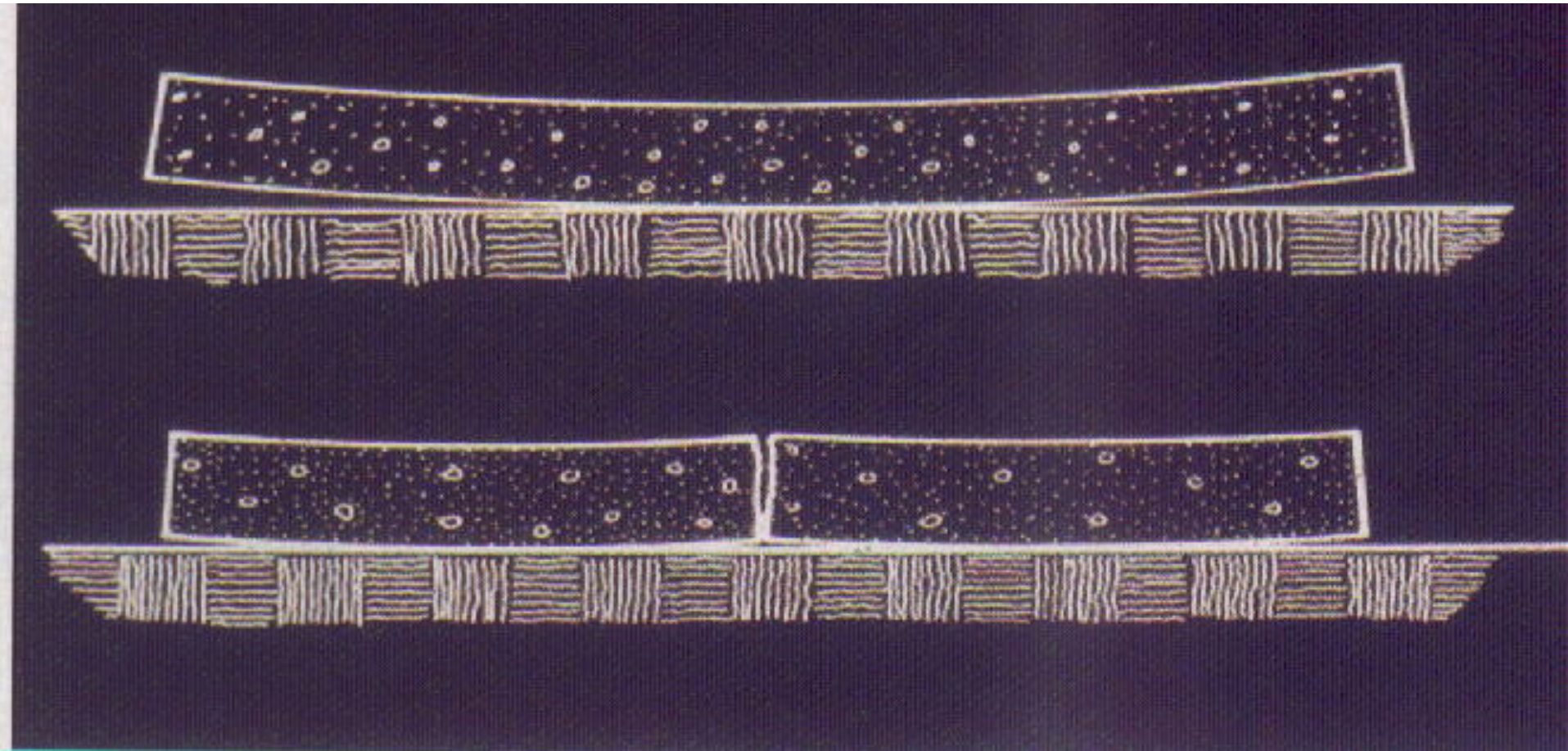
Excess water can't leave through bottom of slab



Vapor barrier under slab

Water cure can lead to:

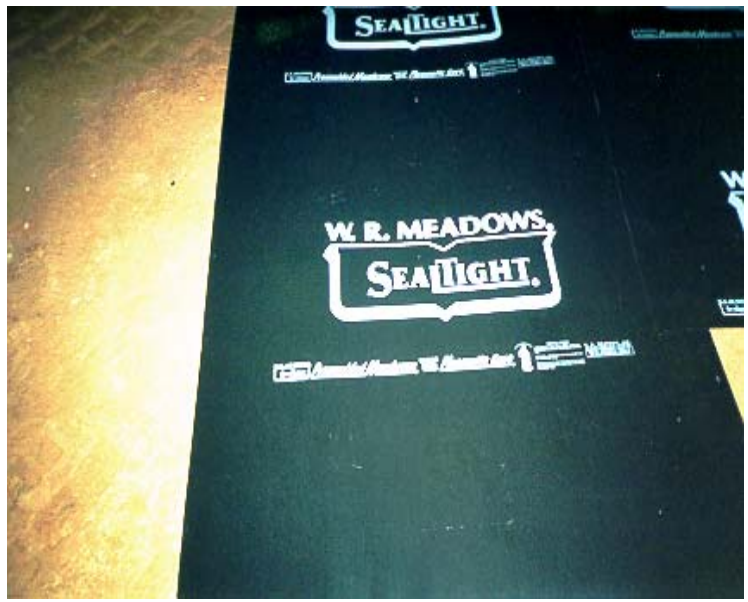
Slab Curl



Consider Durability

- ASTM E 1993

"Standard Specification for Bituminous Water Vapor Retarders used in Contact with Soil or Granular Fill under Concrete Slabs."



SPORT FLOORS, INC.

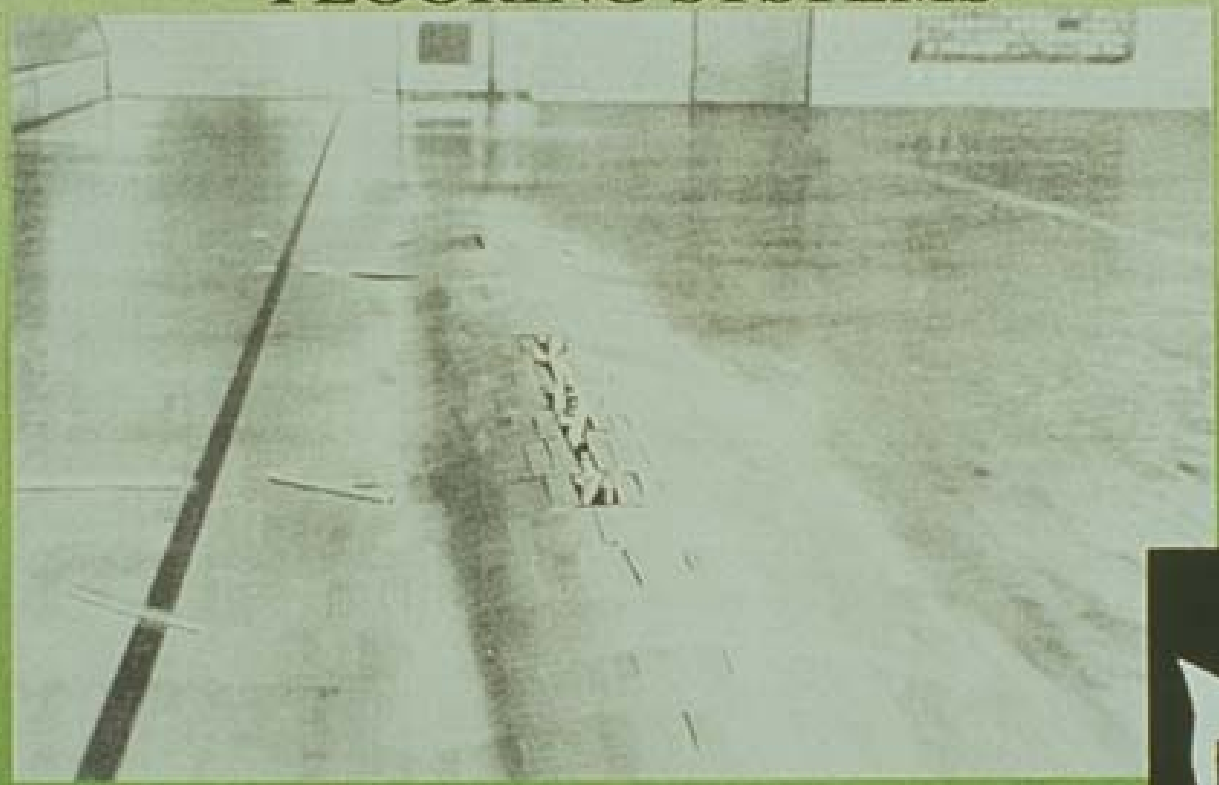
Sport-Flor

THE PRACTICAL SPORTS FLOOR

AGA

Robbins Sports Surfaces

HARD MAPLE FLOORING SYSTEMS



TARKETT

Marlin SURFACING, INC.

MFMA

MAPLE FLOORING MANUFACTURERS ASSN.


16 7 02

INSTALLATION TIMING IS CRITICAL


10 15 '02


SECOND COURSE PANEL POSITIONING
ADDITIONAL COURSES.
3. WHEN TRIMMING, LAY PANELS FLAT AND CUT LONGITUDINALLY WITH FLUTES, OR SWAB CROSS-CUT FLUTES WITH WATER BEFORE HANDLING.
9. PROTECT PANELS AGAINST PRECIPITATION AND CONSTRUCTION DAMAGE AT ALL TIMES BEFORE AND DURING BACKFILL.
MADE IN U.S.A.

PROTECT YOUR WATERPROOFING